**Chapter 6 Electrical Systems**

6.1\* Applicability

6.1.1

This chapter shall apply to new health care facilities as specified in Section 1.3.

6.1.2

The following paragraphs of this chapter shall apply to new; and existing health care facilities:

6.3.2.2.4.2

6.3.2.2.6.1

6.3.2.2.6.2(F)

6.3.2.2.8.5(B) (2), (3), and (4)

6.3.2.2.8.7

6.3.4

6.4.1.1.17.5

6.4.2.2.6.2(C)

6.4.2.2.6.3

6.4.4

6.5.4

6.6.2.2.3.2

6.6.3.1

6.6.4

6.1.3

Paragraph 6.3.2.2.2.3 shall apply only to existing facilities.

6.2 Nature of Hazards

6.2.1\* Fire and Explosions

6.2.2 Shock. (Reserved)

6.2.3 Thermal. (Reserved)

6.3 Electrical System

6.3.1 Sources

Each hospital appliance requiring electrical line power for operation shall be supported by power sources and distribution systems that provide power adequate for each service.

6.3.1.1 Power/Utility Company. (Reserved)

6.3.1.2 On-Site Generator Set. (Reserved)

6.3.2 Distribution

6.3.2.1 Electrical Installation

Installation shall be in accordance with NFPA 70, National Electrical Code.

6.3.2.1.1

Distribution system arrangements shall be designed to minimize interruptions to the electrical systems due to internal failures by the use of adequately rated equipment.

6.3.2.2\* All Patient Care Rooms

6.3.2.2.1\*

Regular voltage wiring shall comply with the requirements in 6.3.2.2.1.1 through 6.3.2.2.1.4.

6.3.2.2.1.1\* Circuits

(A)

Branch circuits serving a given patient bed location shall be fed from not more than one normal branch-circuit distribution panel.

(B)

When required, branch circuits serving a given patient bed location shall be permitted to be fed from more than one critical branch-circuit distribution panel.

6.3.2.2.1.2 Critical Care Areas

Critical care areas shall be served by circuits from a critical branch panel(s) served from a single automatic transfer switch and a minimum of one circuit served by the normal power distribution system or by a system originating from a second critical branch automatic transfer switch.

6.3.2.2.1.3 Access to Overcurrent Protective Devices

(A)

Only authorized personnel shall have access to overcurrent protective devices serving Category 1 and Category 2 rooms.

(B)

Overcurrent protective devices serving Category 1 and Category 2 rooms shall not be permitted to be located in public access spaces.

(C)

Where used in locations such as in critical care areas, isolated power panels shall be permitted in those locations.

6.3.2.2.1.4 Special-Purpose Outlets

Branch circuits serving only special-purpose outlets or receptacles (e.g., portable X-ray receptacles) shall not be required to conform to the requirements of 6.3.2.2.1.2.

6.3.2.2.2

Grounding requirements shall comply with the requirements in 6.3.2.2.2.1 through 6.3.2.2.2.4.

6.3.2.2.2.1 Grounding Circuitry Integrity

Grounding circuits and conductors in patient care rooms shall be installed in such a way that the continuity of other parts of those circuits cannot be interrupted nor the resistance raised above an acceptable level by the installation, removal, and replacement of any installed equipment, including power receptacles.

6.3.2.2.2.2\* Reliability of Grounding

(A)

Where used, the reliability of grounding circuits installed to a power receptacle in all patient care rooms shall be at least equivalent to that provided by an electrically continuous copper conductor of appropriate ampacity run from the receptacle to a grounding bus in the distribution panel.

(B)

The grounding conductor shall conform to NFPA 70, National Electrical Code.

6.3.2.2.2.3 Separate Grounding Conductor

When existing construction does not have a separate grounding conductor, the continued use of the system shall be permitted, provided that it meets the performance requirements in 6.3.3.1.

6.3.2.2.2.4 Metal Receptacle Boxes

Where metal receptacle boxes are used, the performance of the connection between the receptacle grounding terminal and the metal box shall be equivalent to the performance provided by copper wire no smaller than 12 AWG.

6.3.2.2.3\* Grounding Interconnects

In patient care rooms supplied by the normal distribution system and any branch of the essential electrical system, the grounding system of the normal distribution system and that of the essential electrical system shall be interconnected.

6.3.2.2.4 Protection Against Ground Faults

6.3.2.2.4.1\* Equipment Protection

The main and downstream ground-fault protective devices (where required) shall be coordinated as required in 6.3.2.5.

6.3.2.2.4.2\* Personnel Protection

If used, ground-fault circuit interrupters (GFCIs) shall be listed.

6.3.2.2.5

Low-voltage wiring shall comply with either of the following:

Fixed systems of 30 V (dc or ac rms) or less shall be permitted to be ungrounded, provided that the insulation between each ungrounded conductor and the primary circuit, which is supplied from a conventionally grounded distribution system, is the same protection as required for the primary voltage.

A grounded low-voltage system shall be permitted, provided that load currents are not carried in the grounding conductors.

6.3.2.2.6 Receptacles

6.3.2.2.6.1\* Types of Receptacles

(A)

Each power receptacle shall provide at least one, separate, highly dependable grounding pole capable of maintaining low-contact resistance with its mating plug, despite electrical and mechanical abuse.

(B)

Special receptacles, such as the following, shall be permitted:

Four-pole units providing an extra pole for redundant grounding or ground continuity monitoring

Locking-type receptacles

Where required for reduction of electrical noise on the grounding circuit, receptacles in which the grounding terminals are purposely insulated from the receptacle yoke

6.3.2.2.6.2 Minimum Number of Receptacles

The number of receptacles shall be determined by the intended use of the patient care rooms in accordance with 6.3.2.2.6.2(A) through 6.3.2.2.6.2(E).

(A) Receptacles for Patient Bed Locations in General Care Areas (Category 2)

Each patient bed location shall be provided with a minimum of eight receptacles.

(B) Receptacles for Patient Bed Locations in Critical Care Areas (Category 1)

Each patient bed location shall be provided with a minimum of 14 receptacles.

(C) Receptacles for Operating Rooms (Category 1)

Operating rooms shall be provided with a minimum of 36 receptacles.

(D) Receptacles for Bathrooms or Toilets

Receptacles shall not be required in bathrooms or toilet rooms.

(E) Receptacles for Special Rooms

Receptacles shall not be required in rooms where medical requirements mandate otherwise (e.g., certain psychiatric, pediatric, or hydrotherapy rooms).

(F) Designated General Care Pediatric Locations

Receptacles that are located within the patient rooms, bathrooms, playrooms, and activity rooms of pediatric units, other than nurseries, shall be listed tamper-resistant or shall employ a listed tamper-resistant cover.

6.3.2.2.6.3 Polarity of Receptacles

Each receptacle shall be wired in accordance with NFPA 70, National Electrical Code, to ensure correct polarity.

6.3.2.2.6.4 Receptacles and Amperage

(A)

Receptacles for use with 250-V, 50-A, and 60-A ac service shall be designed for use in locations where deep sedation or general anesthesia is administered and shall be so designed that the 60-A receptacle will accept either the 50-A or the 60-A plug.

(B)

Fifty-ampere receptacles shall be designed so as not to accept the 60-A attachment plug.

(C)

Both 50-A and 60-A receptacles shall be of the two-pole, three-wire design, with the third contact connecting to the grounding wire (green or green with yellow stripe) of the electrical system.

6.3.2.2.6.5 Other Services Receptacles

Receptacles provided for other services having different voltages, frequencies, or types on the same premises shall be of such design that attachment plugs and caps used in such receptacles cannot be connected to circuits of a different voltage, frequency, or type, but shall be interchangeable within each classification and rating required for two-wire, 125-V, single-phase ac service.

6.3.2.2.7 Special Grounding

6.3.2.2.7.1\* Use of Isolated Ground Receptacles

(A)

An isolated ground receptacle, if used, shall not defeat the purposes of the safety features of the grounding systems detailed herein.

(B)

An isolated ground receptacle shall not be installed within a patient care vicinity.

6.3.2.2.7.2 Patient Equipment Grounding Point

A patient equipment grounding point comprising one or more grounding terminals or jacks shall be permitted in an accessible location in the patient care vicinity.

6.3.2.2.7.3\* Special Grounding in Patient Care Rooms

In addition to the grounding required to meet the performance requirements of 6.3.3.1, additional grounding shall be permitted where special circumstances so dictate.

6.3.2.2.8 Wet Procedure Locations

6.3.2.2.8.1\*

Wet procedure locations shall be provided with special protection against electric shock.

6.3.2.2.8.2

This special protection shall be provided as follows:

Power distribution system that inherently limits the possible ground-fault current due to a first fault to a low value, without interrupting the power supply

\*Power distribution system in which the power supply is interrupted if the ground-fault current does, in fact, exceed the trip value of a Class A GFCI

6.3.2.2.8.3

Patient beds, toilets, bidets, and wash basins shall not be required to be considered wet procedure locations.

6.3.2.2.8.4\*

Operating rooms shall be considered to be a wet procedure location, unless a risk assessment conducted by the health care governing body determines otherwise.

6.3.2.2.8.5

In existing construction, the requirements of 6.3.2.2.8.1 shall not be required when a written inspection procedure, acceptable to the authority having jurisdiction, is continuously enforced by a designated individual at the hospital to indicate that equipment grounding conductors for 120-V, single-phase, 15-A and 20-A receptacles; equipment connected by cord and plug; and fixed electrical equipment are installed and maintained in accordance with NFPA 70, National Electrical Code, and the applicable performance requirements of this chapter.

(A)

The procedure shall include electrical continuity tests of all required equipment, grounding conductors, and their connections.

(B)

Fixed receptacles, equipment connected by cord and plug, and fixed electrical equipment shall be tested as follows:

When first installed

Where there is evidence of damage

After any repairs

At intervals not exceeding 6 months

6.3.2.2.8.6

The use of an isolated power system (IPS) shall be permitted as a protective means capable of limiting ground-fault current without power interruption. When installed, such a power system shall conform to the requirements of 6.3.2.6.

6.3.2.2.8.7\*

Operating rooms defined as wet procedure locations shall be protected by either isolated power or ground-fault circuit interrupters.

6.3.2.2.9 Isolated Power

6.3.2.2.9.1

An isolated power system shall not be required to be installed in any patient care room, except as specified in 6.3.2.2.8.

6.3.2.2.9.2

The system shall be permitted to be installed where it conforms to the performance requirements specified in 6.3.2.6.

6.3.2.2.10 Essential Electrical Systems (EES)

6.3.2.2.10.1

Critical care rooms (Category 1 Room) shall be served only by a Type I EES.

6.3.2.2.10.2

General care rooms (Category 2 Room) shall be served by a Type I or Type II EES.

6.3.2.2.10.3

A Type I EES serving a critical care room (Category 1 Room) shall be permitted to serve general care rooms (Category 2 Room) in the same facility.

6.3.2.2.10.4

Basic care rooms shall not be required to be served by an EES.

6.3.2.2.10.5

Rooms other than patient care rooms shall not be required to be served by an EES.

6.3.2.2.11 Battery-Powered Lighting Units

6.3.2.2.11.1

One or more battery-powered lighting units shall be provided within locations where deep sedation and general anesthesia is administered.

6.3.2.2.11.2

The lighting level of each unit shall be sufficient to terminate procedures intended to be performed within the operating room.

6.3.2.2.11.3

The sensor for units shall be wired to the branch circuit(s) serving general lighting within the room.

6.3.2.2.11.4

Units shall be capable of providing lighting for 11/2 hours.

6.3.2.2.11.5

Units shall be tested monthly for 30 seconds, and annually for 30 minutes.

6.3.2.3 Laboratories

Outlets with two to four receptacles, or an equivalent power strip, shall be installed every 0.5 m to 1.0 m (1.6 ft to 3.3 ft) in instrument usage areas, and either installation shall be at least 80 mm (3.15 in.) above the countertop.

6.3.2.4 Other Nonpatient Areas. (Reserved)

6.3.2.5 Ground-Fault Protection

6.3.2.5.1 Applicability

The requirements of 6.3.2.5.2 shall apply to hospitals and other buildings housing critical care areas or utilizing life-support equipment and buildings that provide essential utilities or services for the operation of critical-care areas or electrical life-support equipment.

6.3.2.5.2

When ground-fault protection is provided for operation of the service or feeder disconnecting means, an additional step of ground-fault protection shall be provided in the next level of feeder downstream toward the load.

6.3.2.5.3

Ground-fault protection for operation of the service and feeder disconnecting means shall be fully selective such that the downstream device and not the upstream device shall open for downstream ground faults.

6.3.2.6\* Isolated Power Systems

6.3.2.6.1 Isolation Transformer

6.3.2.6.1.1

The isolation transformer shall be listed and approved for the purpose.

6.3.2.6.1.2

The primary winding shall be connected to a power source so that it is not energized with more than 600 V (nominal).

(A)

The neutral of the primary winding shall be grounded in an approved manner.

(B)

If an electrostatic shield is present, it shall be connected to the reference grounding point.

6.3.2.6.1.3

Wiring of isolated power systems shall be in accordance with 517.62 of NFPA 70, National Electrical Code.

6.3.2.6.2 Impedance of Isolated Wiring

6.3.2.6.2.1\*

The impedance (capacitive and resistive) to ground of either conductor of an isolated system shall exceed 200,000 ohms when installed. The installation at this point shall include receptacles but is not required to include lighting fixtures or components of fixtures. This value shall be determined by energizing the system and connecting a low-impedance ac milliammeter (0 to 1 mA scale) between the reference grounding point and either conductor in sequence. This test shall be permitted to be performed with the line isolation monitor (see 6.3.2.6.3) connected, provided that the connection between the line isolation monitor and the reference grounding point is open at the time of the test. After the test is made, the milliammeter shall be removed and the grounding connection of the line isolation monitor shall be restored. When the installation is completed, including permanently connected fixtures, the reading of the meter on the line isolation monitor, which corresponds to the unloaded line condition, shall be made. This meter reading shall be recorded as a reference for subsequent line impedance evaluation. This test shall be conducted with no phase conductors grounded.

6.3.2.6.2.2

An approved capacitance suppressor shall be permitted to be used to improve the impedance of the permanently installed isolated system; however, the resistive impedance to ground of each isolated conductor of the system shall be at least 1 megohm prior to the connection of the suppression equipment. Capacitance suppressors shall be installed so as to prevent inadvertent disconnection during normal use.

6.3.2.6.3 Line Isolation Monitor

6.3.2.6.3.1\*

In addition to the usual control and protective devices, each isolated power system shall be provided with an approved, continually operating line isolation monitor that indicates possible leakage or fault currents from either isolated conductor to ground.

6.3.2.6.3.2

The monitor shall be designed such that a green signal lamp, conspicuously visible in the area where the line isolation monitor is utilized, remains lighted when the system is adequately isolated from ground; and an adjacent red signal lamp and an audible warning signal (remote if desired) shall be energized when the total hazard current (consisting of possible resistive and capacitive leakage currents) from either isolated conductor to ground reaches a threshold value of 5.0 mA under normal line voltage conditions. The line isolation monitor shall not alarm for a fault hazard current of less than 3.7 mA.

6.3.2.6.3.3\*

The line isolation monitor shall comply with either of the following:

It shall have sufficient internal impedance such that, when properly connected to the isolated system, the maximum internal current that will flow through the line isolation monitor, when any point of the isolated system is grounded, shall be 1 mA.

It shall be permitted to be of the low-impedance type such that the current through the line isolation monitor, when any point of the isolated system is grounded, will not exceed twice the alarm threshold value for a period not exceeding 5 milliseconds.

6.3.2.6.3.4\*

An ammeter connected to indicate the total hazard current of the system (contribution of the fault hazard current plus monitor hazard current) shall be mounted in a plainly visible place on the line isolation monitor with the "alarm on" zone (total hazard current = 5.0 mA) at approximately the center of the scale. A line isolation monitor shall be located in the operating room.

6.3.2.6.3.5

Means shall be provided for shutting off the audible alarm while leaving the red warning lamp activated. When the fault is corrected and the green signal lamp is reactivated, the audible alarm-silencing circuit shall reset automatically, or an audible or distinctive visual signal shall indicate that the audible alarm is silenced.

6.3.2.6.3.6

A reliable test switch shall be mounted on the line isolation monitor to test its capability to operate (i.e., cause the alarms to operate and the meter to indicate in the "alarm on" zone). This switch shall transfer the grounding connection of the line isolation monitor from the reference grounding point to a test impedance arrangement connected across the isolated line; the test impedance(s) shall be of the appropriate magnitude to produce a meter reading corresponding to the rated total hazard current at the nominal line voltage, or to a lesser alarm hazard current if the line isolation monitor is so rated. The operation of this switch shall break the grounding connection of the line isolation monitor to the reference grounding point before transferring this grounding connector to the test impedance(s), so that making this test will not add to the hazard of a system in actual use; nor will the test include the effect of the line-to-ground stray impedance of the system. The test switch shall be of a self-restoring type.

6.3.2.6.3.7

The line isolation monitor shall not generate energy of sufficient amplitude or frequency, as measured by a physiological monitor with a gain of at least 104 with a source impedance of 1000 ohms connected to the balanced differential input of the monitor, to create interference or artifact on human physiological signals. The output voltage from the amplifier shall not exceed 30 mV when the gain is 104. The impedance of 1000 ohms shall be connected to the ends of typical unshielded electrode leads that are a normal part of the cable assembly furnished with physiological monitors. A 60 Hz notch filter shall be used to reduce ambient interference, as is typical in physiological monitor design.

6.3.2.6.4 Identification of Conductors for Isolated (Ungrounded) Systems

The isolated conductors shall be identified in accordance with 517.160(a) (5) of NFPA 70, National Electrical Code.

6.3.3 Performance Criteria and Testing

6.3.3.1 Grounding System in Patient Care Rooms

6.3.3.1.1\* Grounding System Testing

The effectiveness of the grounding system shall be determined by voltage measurements and impedance measurements.

6.3.3.1.1.1

For new construction, the effectiveness of the grounding system shall be evaluated before acceptance.

6.3.3.1.1.2

Small wall-mounted conductive surfaces not likely to become energized, such as surface-mounted towel and soap dispensers, mirrors, and so forth, shall not be required to be intentionally grounded or tested.

6.3.3.1.1.3

Large metal conductive surfaces not likely to become energized, such as windows, door frames, and drains, shall not be required to be intentionally grounded or periodically tested.

6.3.3.1.1.4\*

Whenever the electrical system has been altered or replaced, that portion of the system shall be tested.

6.3.3.1.2 Reference Point

The voltage and impedance measurements shall be taken with respect to a reference point, which shall be one of the following:

Reference grounding point (see Chapter 3)

Grounding point, in or near the room under test, that is electrically remote from receptacles (e.g., an all-metal cold-water pipe)

Grounding contact of a receptacle that is powered from a different branch circuit from the receptacle under test

6.3.3.1.3\* Voltage Measurements

6.3.3.1.3.1

The voltage measurements shall be made under no-fault conditions between a reference point and exposed fixed electrical equipment with conductive surfaces in a patient care vicinity.

6.3.3.1.3.2

The voltage measurements shall be made with an accuracy of ±20 percent.

6.3.3.1.3.3

Voltage measurements for faceplates of wiring devices shall not be required.

6.3.3.1.4\* Impedance Measurements

The impedance measurement shall be made with an accuracy of ±20 percent.

6.3.3.1.4.1

For new construction, the impedance measurement shall be made between the reference point and the grounding contact of 10 percent of all receptacles within the patient care vicinity.

6.3.3.1.4.2

The impedance measurement shall be the ratio of voltage developed (either 60 Hz or dc) between the point under test and the reference point to the current applied between these two points.

6.3.3.1.5 Test Equipment

Electrical safety test instruments shall be tested periodically, but not less than annually, for acceptable performance.

6.3.3.1.5.1

Voltage measurements specified in 6.3.3.1.3 shall be made with an instrument having an input resistance of 1000 ohms ±10 percent at frequencies of 1000 Hz or less.

6.3.3.1.5.2

The voltage across the terminals (or between any terminal and ground) of resistance-measuring instruments used in occupied patient care rooms shall not exceed 500 mV rms or 1.4 dc or peak to peak.

6.3.3.1.6 Criteria for Acceptability for New Construction

6.3.3.1.6.1

The voltage limit shall be 20 mV.

6.3.3.1.6.2

The impedance limit shall be 0.2 ohm for systems containing isolated ground receptacles and 0.1 ohm for all others.

6.3.3.2 Receptacle Testing in Patient Care Rooms

6.3.3.2.1

The physical integrity of each receptacle shall be confirmed by visual inspection.

6.3.3.2.2

The continuity of the grounding circuit in each electrical receptacle shall be verified.

6.3.3.2.3

Correct polarity of the hot and neutral connections in each electrical receptacle shall be confirmed.

6.3.3.2.4

The retention force of the grounding blade of each electrical receptacle (except locking-type receptacles) shall be not less than 115 g (4 oz).

6.3.3.3 Isolated Power Systems

6.3.3.3.1 Patient Care Rooms

If installed, the isolated power system shall be tested in accordance with 6.3.3.3.2.

6.3.3.3.2 Line Isolation Monitor Tests

The line isolation monitor (LIM) circuit shall be tested after installation, and prior to being placed in service, by successively grounding each line of the energized distribution system through a resistor whose value is 200 × V (ohms), where V equals measured line voltage. The visual and audible alarms (see 6.3.2.6.3.2) shall be activated.

6.3.3.4 Ground-Fault Protection Testing

When equipment ground-fault protection is first installed, each level shall be performance-tested to ensure compliance with 6.3.2.5.

6.3.4\* Administration of Electrical System

6.3.4.1 Maintenance and Testing of Electrical System

6.3.4.1.1

Where hospital-grade receptacles are required at patient bed locations and in locations where deep sedation or general anesthesia is administered, testing shall be performed after initial installation, replacement, or servicing of the device.

6.3.4.1.2

Additional testing of receptacles in patient care rooms shall be performed at intervals defined by documented performance data.

6.3.4.1.3

Receptacles not listed as hospital-grade, at patient bed locations and in locations where deep sedation or general anesthesia is administered, shall be tested at intervals not exceeding 12 months.

6.3.4.1.4

The LIM circuit shall be tested at intervals of not more than 1 month by actuating the LIM test switch (see 6.3.2.6.3.6). For a LIM circuit with automated self-test and self-calibration capabilities, this test shall be performed at intervals of not more titan 12 months. Actuation of the test switch shall activate both visual and audible alarm indicators.

6.3.4.1.5

After any repair or renovation to an electrical distribution system, the LIM circuit shall be tested in accordance with 6.3.3.3.2.

6.3.4.2 Record Keeping

6.3.4.2.1\* General

6.3.4.2.1.1

A record shall be maintained of the tests required by this chapter and associated repairs or modification.

6.3.4.2.1.2

At a minimum, the record shall contain the date, the rooms or areas tested, and an indication of which items have met, or have failed to meet, the performance requirements of this chapter.

6.3.4.2.2 Isolated Power System (Where Installed)

A permanent record shall be kept of the results of each of the tests.

6.4 Essential Electrical System Requirements — Type 1

6.4.1 Sources (Type 1 EES)

6.4.1.1 On-Site Generator Set

6.4.1.1.1\* Design Considerations

Dual sources of normal power shall be considered but shall not constitute an alternate source of power as described in this chapter.

6.4.1.1.1.1

Distribution system arrangements shall be designed to minimize interruptions to the electrical systems due to internal failures by the use of adequately rated equipment.

6.4.1.1.1.2

The following factors shall be considered in the design of the distribution system:

Abnormal voltages, such as single phasing of three-phase utilization equipment; switching or lightning surges, or both; voltage reductions; and so forth

Capability of achieving the fastest possible restoration of any given circuit(s) after clearing a fault

Effects of future changes, such as increased loading or supply capacity, or both

Stability and power capability of the prime mover during and after abnormal conditions

\*Sequence reconnection of loads to avoid large current inrushes that trip overcurrent devices or overload the generator(s)

Bypass arrangements to allow testing and maintenance of system components that could not otherwise be maintained without disruption of important hospital functions

Effects of any harmonic currents on neutral conductors and equipment

6.4.1.1.2

Current-sensing devices, phase and ground, shall be selected to minimize the extent of interruption to the electrical system due to abnormal current caused by overload or short circuits, or both.

6.4.1.1.3

Generator load-shed circuits designed for the purpose of load reduction or for load priority systems shall not shed life safety branch loads, critical branch loads serving critical care areas, medical air compressors, medical—surgical vacuum pumps, the pressure maintenance (jockey) pump(s) for water-based fire protection systems, generator fuel pumps, or other generator accessories.

6.4.1.1.4

Essential electrical systems shall have a minimum of the following two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted.

6.4.1.1.5

Where the normal source consists of generating units on the premises, the alternate source shall be either another generating set or an external utility service.

6.4.1.1.6 General

Generator sets installed as an alternate source of power for essential electrical systems shall be designed to meet the requirements of such service.

6.4.1.1.6.1

Type 1 and Type 2 essential electrical system power sources shall be classified as Type 10, Class X, Level 1 generator sets per NFPA 110, Standard for Emergency and Standby Power Systems.

6.4.1.1.6.2

Type 3 essential electrical system power sources shall be classified as Type 10, Class X, Level 2 generator sets per NFPA 110, Standard for Emergency and Standby Power Systems.

6.4.1.1.7 Uses for Essential Electrical System

6.4.1.1.7.1

The generating equipment used shall be either reserved exclusively for such service or normally used for other purposes of peak demand control, internal voltage control, load relief for the external utility, or cogeneration. If normally used for such other purposes, two or more sets shall be installed, such that the maximum actual demand likely to be produced by the connected load of the life safety and critical branches, as well as medical air compressors, medical—surgical vacuum pumps, electrically operated fire pumps, jockey pumps, fuel pumps, and generator accessories, shall be met by a multiple generator system, with the largest generator set out of service (not available). The alternate source of emergency power for illumination and identification of means of egress shall be the essential electrical system. The alternate power source for fire protection signaling systems shall be the essential electrical system.

6.4.1.1.7.2

A single generator set that operates the essential electrical system shall be permitted to be part of the system supplying the other purposes as specified in 6.4.1.1.7.1, provided that any such use will not decrease the mean period between service overhauls to less than 3 years.

6.4.1.1.7.3\*

Optional loads shall be permitted to be served by the essential electrical system generating equipment. Optional loads shall be served by their own transfer means, such that these loads shall not be transferred onto the generating equipment if the transfer will overload the generating equipment and shall be shed upon a generating equipment overload. Use of the generating equipment to serve optional loads shall not constitute "other purposes" as described in 6.4.1.1.7.1 and, therefore, shall not require multiple generator sets.

6.4.1.1.7.4

Where optional loads include contiguous or same-site facilities not covered in this code, provisions shall be made to meet the requirements of NFPA 101, Life Safety Code, Article 700 of NFPA 70, National Electrical Code, and other applicable NFPA requirements for emergency egress under load-shed conditions.

6.4.1.1.8 Work Space or Room

6.4.1.1.8.1

The EPS shall be installed in a separate room for Level 1 installations. EPSS equipment shall be permitted to be installed in this room. [110:7.2.1]

(A)

The room shall have a minimum 2-hour fire rating or be located in an adequate enclosure located outside the building capable of resisting the entrance of snow or rain at a maximum wind velocity required by local building codes. [110:7.2.1.1]

(B)

The rooms, shelters, or separate buildings housing Level 1 or Level 2 EPSS equipment shall be designed and located to minimize the damage from flooding, including that caused by the following:

Flooding resulting from fire fighting

Sewer water backup

Similar disasters or occurrences [110:7.2.3]

6.4.1.1.8.2

The EPS equipment shall be installed in a location that permits ready accessibility and a minimum of 0.9 m (36 in.) from the skid rails' outermost point in the direction of access for inspection, repair, maintenance, cleaning, or replacement. This requirement shall not apply to units in outdoor housings. [110:7.2.5]

6.4.1.1.9\* Capacity and Rating

The generator set(s) shall have sufficient capacity and proper rating to meet the maximum actual demand likely to be produced by the connected load of the essential electrical system(s).

6.4.1.1.10 Load Pickup

The energy converters shall have the required capacity and response to pick up and carry the load within the time specified in Table 4.1(b) of NFPA 110, Standard for Emergency and Standby Power Systems, after loss of primary power.

6.4.1.1.11 Maintenance of Temperature

The EPS shall be heated as necessary to maintain the water jacket temperature determined by the EPS manufacturer for cold start and load acceptance for the type of EPSS. [110:5.3.1]

6.4.1.1.12\* Heating, Cooling, and Ventilating

With the EPS running at rated load, ventilation airflow shall be provided to limit the maximum air temperature in the EPS room to the maximum ambient air temperature required by the EPS manufacturer. [110:7.7.1]

6.4.1.1.12.1

Consideration shall be given to all the heat emitted to the EPS equipment room by the energy converter, uninsulated or insulated exhaust pipes, and other heat-producing equipment. [110:7.7.1.1]

6.4.1.1.12.2

Air shall be supplied to the EPS equipment for combustion. [110:7.7.2]

(A)

For EPS supplying Level 1 EPSS, ventilation air shall be supplied directly from a source outside of the building by an exterior wall opening or from a source outside the building by a 2-hour fire-rated air transfer system. [110:7.7.2.1]

(B)

For EPS supplying Level 1 EPSS, discharge air shall be directed outside the building by an exterior wall opening or to an exterior opening by a 2-hour fire-rated air transfer system. [110:7.7.2.2]

(C)

Fire dampers, shutters, or other self-closing devices shall not be permitted in ventilation openings or ductwork for supply or return/discharge air to EPS equipment for Level 1 EPSS. [110:7.7.2.3]

6.4.1.1.12.3

Ventilation air supply shall be from outdoors or from a source outside of the building by an exterior wall opening or from a source outside the building by a 2-hour fire-rated air transfer system. [110:7.7.3]

6.4.1.1.12.4

Ventilation air shall be provided to supply and discharge cooling air for radiator cooling of the EPS when running at rated load. [110:7.7.4]

(A)

Ventilation air supply and discharge for radiator-cooled EPS shall have a maximum static restriction of 125 Pa (0.5 in. of water column) in the discharge duct at the radiator outlet. [110:7.7.4.1]

(B)

Radiator air discharge shall be ducted outdoors or to an exterior opening by a 2-hour rated air transfer system. [110:7.7.4.2]

6.4.1.1.12.5

Motor-operated dampers, when used, shall be spring operated to open and motor closed. Fire dampers, shutters, or other self-closing devices shall not be permitted in ventilation openings or ductwork for supply or return/discharge air to EPS equipment for Level 1 EPSS. [110:7.7.5]

6.4.1.1.12.6

The ambient air temperature in the EPS equipment room or outdoor housing containing Level 1 rotating equipment shall be not less than 4.5°C (40°F). [110:7.7.6]

6.4.1.1.12.7

Units housed outdoors shall be heated as specified in 5.3.1 [of NFPA 110, Standard for Emergency and Standby Power Systems]. [110:7.7.7]

6.4.1.1.12.8

Design of the heating, cooling, and ventilation system for the EPS equipment room shall include provision for factors including, but not limited to, the following:

Heat

Cold

Dust

Humidity

Snow and ice accumulations around housings

Louvers

Remote radiator fans

Prevailing winds blowing against radiator fan discharge air [110:7.7.8]

6.4.1.1.13 Cranking Batteries

Internal combustion engine cranking batteries shall be in accordance with the battery requirements of NFPA 110, Standard for Emergency and Standby Power Systems.

6.4.1.1.14 Compressed Air Starting Devices

Other types of stored energy starting systems (except pyrotechnic) shall be permitted to be used where recommended by the manufacturer of the prime mover and subject to approval of the authority having jurisdiction, under the following conditions:

Where two complete periods of cranking cycles are completed without replacement of the stored energy

Where a means for automatic restoration from the emergency source of the stored energy is provided

Where the stored energy system has the cranking capacity specified in 5.6.4.2.1 of NFPA 110, Standard for Emergency and Standby Power Systems

Where the stored energy system has a "black start" capability in addition to normal discharge capability [110:5.6.4.1.2]

6.4.1.1.15 Fuel Supply

The fuel supply for the generator set shall comply with Sections 5.5 and 7.9 of NFPA 110, Standard for Emergency and Standby Power Systems.

6.4.1.1.16 Requirements for Safety Devices

6.4.1.1.16.1 Internal Combustion Engines

Internal combustion engines serving generator sets shall be equipped with the following:

Sensor device plus visual warning device to indicate a water-jacket temperature below that required in 6.4.1.1.11

Sensor devices plus visual pre-alarm warning device to indicate the following:

High engine temperature (above manufacturer's recommended safe operating temperature range)

Low lubricating oil pressure (below manufacturer's recommended safe operating range)

Low water coolant level

Automatic engine shutdown device plus visual device to indicate that a shutdown took place due to the following:

Overcrank (failed to start)

Overspeed

Low lubricating oil pressure

Excessive engine temperature

Common audible alarm device to warn that one or more of the pre-alarm or alarm conditions exist

6.4.1.1.16.2

Safety indications and shutdowns shall be in accordance with Table 6.4.1.1.16.2.

Table 6.4.1.1.16.2 Safety Indications and Shutdowns

Indicator Function (at Battery Voltage) Level 1

CV S RA

(a) Overcrank X X X

(b) Low water temperature X — X

(c) High engine temperature pre-alarm X — X

(d) High engine temperature X X X

(e) Low lube oil pressure pre-alarm X — X

(f) Low lube oil pressure X X X

(g) Overspeed X X X

(h) Low fuel main tank X — X

(i) Low coolant level X O X

(j) EPS supplying load X — —

(k) Control switch not in automatic position X — X

(l) High battery voltage X — —

(m) Low cranking voltage X — X

(n) Low voltage in battery X — —

(o) Battery charger ac failure X — —

(p) Lamp test X — —

(q) Contacts for local and remote common alarm X — X

(r) Audible alarm-silencing switch — — X

(s) Low starting air pressure X — —

(t) Low starting hydraulic pressure X — —

(u) Air shutdown damper when used X X X

(v) Remote emergency stop — X —

CV: Control panel—mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required. O: Optional.

Notes:

Item (p) shall be provided, but a separate remote audible signal shall not be required when the regular work site in 5.6.6 of NFPA 110, Standard for Emergency and Standby Power Systems, is staffed 24 hours a day.

Item (b) is not required for combustion turbines.

Item (r) or (s) is required only where used as a starting method.

Item (j): EPS ac ammeter shall be permitted for this function.

All required CV functions shall be visually annunciated by a remote, common visual indicator.

All required functions indicated in the RA column shall be annunciated by a remote, common audible alarm as required in 5.6.5.2(4) of NFPA 110.

Item (i) requires a low gas pressure alarm on gaseous systems.

Item (b) must be set at 11°C (20°F) below the regulated temperature determined by the EPS manufacturer, as required in 5.3.1 of NFPA 110.

6.4.1.1.17 Alarm Annunciator

A remote annunciator that is storage battery powered shall be provided to operate outside of the generating room in a location readily observed by operating personnel at a regular work station (see 700.12 of NFPA 70, National Electrical Code). The annunciator shall be hard-wired to indicate alarm conditions of the emergency or auxiliary power source as follows:

Individual visual signals shall indicate the following:

When the emergency or auxiliary power source is operating to supply power to load

When the battery charger is malfunctioning

Individual visual signals plus a common audible signal to warn of an engine—generator alarm condition shall indicate the following:

Low lubricating oil pressure

Low water temperature (below that required in 6.4.1.1.11)

Excessive water temperature

Low fuel when the main fuel storage tank contains less than a 4-hour operating supply

Overcrank (failed to start)

Overspeed

6.4.1.1.17.1\*

A remote, common audible alarm shall be provided as specified in 6.4.1.1.17.4 that is powered by the storage battery and located outside of the EPS service room at a work site observable by personnel. [110:5.6.6]

6.4.1.1.17.2

An alarm-silencing means shall be provided, and the panel shall include repetitive alarm circuitry so that, after the audible alarm has been silenced, it reactivates after the fault condition has been cleared and has to be restored to its normal position to be silenced again. [110:5.6.6.1]

6.4.1.1.17.3

In lieu of the requirement of 5.6.6.1 of NFPA 110, a manual alarm-silencing means shall be permitted that silences the audible alarm after the occurrence of the alarm condition, provided such means do not inhibit any subsequent alarms from sounding the audible alarm again without further manual action. [110:5.6.6.2]

6.4.1.1.17.4

Individual alarm indication to annunciate any of the conditions listed in Table 6.4.1.1.16.2 shall have the following characteristics:

It shall be battery powered.

It shall be visually indicated.

It shall have additional contacts or circuits for a common audible alarm that signals locally and remotely when any of the itemized conditions occurs.

It shall have a lamp test switch(es) to test the operation of all alarm lamps.

6.4.1.1.17.5

A centralized computer system (e.g., building automation system) shall not be permitted to be substituted for the alarm annunciator in 6.4.1.1.17 but shall be permitted to be used to supplement the alarm annunciator.

6.4.1.2 Battery

Battery systems shall meet all requirements of Article 700 of NFPA 70, National Electrical Code.

6.4.2\* Distribution (Type 1 EES)

6.4.2.1 General Requirements

6.4.2.1.1

Electrical characteristics of the transfer switches shall be suitable for the operation of all functions and equipment they are intended to supply.

6.4.2.1.2\* Selective Coordination

6.4.2.1.2.1

Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.1 second.

6.4.2.1.2.2

Selective coordination shall not be required as follows:

Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary.

Between overcurrent protective devices of the same size (ampere rating) in series.

6.4.2.1.3 Switch Rating

The rating of the transfer switches shall be adequate for switching all classes of loads to be served and for withstanding the effects of available fault currents without contact welding.

6.4.2.1.4 Automatic Transfer Switch

Transfer of all loads shall be accomplished using an automatic transfer switch(es). Each automatic transfer switch of 600 V or less shall be listed for the purpose and approved for emergency electrical service (see NFPA 70, National Electrical Code, Article 700.3) as a complete assembly.

6.4.2.1.5 Automatic Transfer Switch Features

6.4.2.1.5.1 Source Monitoring

(A)\*

Undervoltage-sensing devices shall be provided to monitor all ungrounded lines of the primary source of power as follows:

When the voltage on any phase falls below the minimum operating voltage of any load to be served, the transfer switch shall automatically initiate engine start and the process of transfer to the emergency power supply (EPS).

\*When the voltage on all phases of the primary source returns to within specified limits for a designated period of time, the process of transfer back to primary power shall be initiated. [110:6.2.2.1]

(B)

Both voltage-sensing and frequency-sensing equipment shall be provided to monitor one ungrounded line of the EPS power. [110:6.2.2.2]

(C)

Transfer to the EPS shall be inhibited until the voltage and frequency are within a specified range to handle loads to be served. [110:6.2.2.3]

(D)

Sensing equipment shall not be required in the transfer switch, provided it is included with the engine control panel. [110:6.2.2.3.1]

(E)

Frequency-sensing equipment shall not be required for monitoring the public utility source where used as an EPS, as permitted by 5.1.4 of NFPA 110, Standard for Emergency and Standby Power Systems. [110:6.2.2.3.2]

6.4.2.1.5.2 Interlocking

Mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the primary power supply and the EPS, or any two separate sources of power. [110:6.2.3]

6.4.2.1.5.3\* Manual Operation

Instruction and equipment shall be provided for safe manual nonelectric transfer in the event the transfer switch malfunctions. [110:6.2.4]

6.4.2.1.5.4\* Time Delay on Starting of EPS

A time-delay device shall be provided to delay starting of the EPS. The timer shall prevent nuisance starting of the EPS and possible subsequent load transfer in the event of harmless momentary power dips and interruptions of the primary source. [110:6.2.5]

6.4.2.1.5.5 Time Delay at Engine Control Panel

Time delays shall be permitted to be located at the engine control panel in lieu of in the transfer switches. [110:6.2.6]

6.4.2.1.5.6 Time Delay on Transfer to EPS

An adjustable time-delay device shall be provided to delay transfer and sequence load transfer to the EPS to avoid excessive voltage drop when the transfer switch is installed for Level 1 use. [110:6.2.7]

(A) Time Delay Commencement

The time delay shall commence when proper EPS voltage and frequency are achieved. [110:6.2.7.1]

(B) Time Delay at Engine Control Panel

Time delays shall be permitted to be located at the engine control panel in lieu of in the transfer switches. [110:6.2.7.2]

6.4.2.1.5.7\* Time Delay on Retransfer to Primary Source

An adjustable time-delay device with automatic bypass shall be provided to delay retransfer from the EPS to the primary source of power, and allow the primary source to stabilize before retransfer of the load. [110:6.2.8]

6.4.2.1.5.8 Time Delay Bypass if EPS Fails

The time delay shall be automatically bypassed if the EPS fails. [110:6.2.9]

(A)

The transfer switch shall be permitted to be programmed for a manually initiated retransfer to the primary source to provide for a planned momentary interruption of the load. [110:6.2.9.1]

(B)

If used, the arrangement in 6.2.9.1 of NFPA 110, Standard for Emergency and Standby Power Systems, shall be provided with a bypass feature to allow automatic retransfer in the event that the EPS fails and the primary source is available. [110:6.2.9.2]

6.4.2.1.5.9 Time Delay on Engine Shutdown

A minimum time delay of 5 minutes shall be provided for unloaded running of the EPS prior to shutdown to allow for engine cooldown. [110:6.2.10]

(A)

The minimum 5-minute delay shall not be required on small (15 kW or less) air-cooled prime movers. [110:6.2.10.1]

(B)

A time-delay device shall not be required, provided it is included with the engine control panel, or if a utility feeder is used as an EPS. [110:6.2.10.2]

6.4.2.1.5.10 Engine Generator Exercising Tinier

A program timing device shall be provided to exercise the EPS as described in Chapter 8 of NFPA 110, Standard for Emergency and Standby Power Systems. [110:6.2.11]

(A)

Transfer switches shall transfer the connected load to the EPS and immediately return to primary power automatically in case of the EPS failure. [110:6.2.11.1]

(B)

Exercising timers shall be permitted to be located at the engine control panel in lieu of in the transfer switches. [110:6.2.11.2]

(C)

A program timing device shall not be required in health care facilities that provide scheduled testing in accordance with NFPA 99, Health Care Facilities Code. [110:6.2.11.3]

6.4.2.1.5.11 Test Switch

A test means shall be provided on each automatic transfer switch (ATS) that simulates failure of the primary power source and then transfers the load to the EPS. [110:6.2.12]

6.4.2.1.5.12\* Indication of Switch Position

Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate the transfer switch position. [110:6.2.13]

6.4.2.1.5.13 Motor Load Transfer

Provisions shall be included to reduce currents resulting from motor load transfer if such currents could damage EPSS equipment or cause nuisance tripping of EPSS overcurrent protective devices. [110:6.2.14]

6.4.2.1.5.14\* Isolation of Neutral Conductors

Provisions shall be included for ensuring continuity, transfer, and isolation of the primary and the EPS neutral conductors wherever they are separately grounded to achieve ground-fault sensing. [110:6.2.15]

6.4.2.1.5.15\* Nonautomatic Transfer Switch Features

Switching devices shall be mechanically held and shall be operated by direct manual or electrical remote manual control. [110:6.2.16]

(A) Interlocking

Reliable mechanical interlocking, or an approved alternate method, shall prevent the inadvertent interconnection of the primary power source and the EPS. [110:6.2.16.1]

(B) Indication of Switch Position

Two pilot lights with identification nameplates, or other approved position indicators, shall be provided to indicate the switch position. [110:6.2.16.2]

6.4.2.1.6 Nonautomatic Transfer Device Classification

Non-automatic transfer devices of 600 V or less shall be listed for the purpose and approved.

6.4.2.1.7 Nonautomatic Transfer Device Features

6.4.2.1.7.1 General

Switching devices shall be mechanically held and shall be operated by direct manual or electrical remote manual control. [110:6.2.16]

6.4.2.1.7.2 Interlocking

Reliable mechanical interlocking, or an approved alternate method, shall prevent the inadvertent interconnection of the primary power source and the EPS. [110:6.2.16.1]

6.4.2.1.7.3 Indication of Switch Position

Two pilot lights with identification nameplates, or other approved position indicators, shall be provided to indicate the switch position. [110:6.2.16.2]

6.4.2.1.8 Bypass-Isolation Switches

Bypass-isolation switches shall be permitted for bypassing and isolating the transfer switch and installed in accordance with 6.4.2 through 6.4.3 and 6.4.4. [110:6.4.1]

6.4.2.1.8.1 Bypass-Isolation Switch Rating

The bypass-isolation switch shall have a continuous current rating and a current rating compatible with that of the associated transfer switch. [110:6.4.2]

6.4.2.1.8.2 Bypass-Isolation Switch Classification

Each bypass-isolation switch shall be listed for emergency electrical service as a completely factory-assembled and factory-tested apparatus. [110:6.4.3]

6.4.2.1.8.3\* Operation

With the transfer switch isolated or disconnected, the bypass-isolation switch shall be designed so it can function as an independent nonautomatic transfer switch and allow the load to be connected to either power source. [110:6.4.4]

6.4.2.1.8.4 Reconnection of Transfer Switch

Reconnection of the transfer switch shall be possible without a load interruption greater than the maximum time, in seconds, specified by the type of system. [110:6.4.5]

6.4.2.2 Branches

6.4.2.2.1\* General

6.4.2.2.1.1

The essential electrical system shall be divided into the following three branches:

Life safety

Critical

Equipment

6.4.2.2.1.2

The division between the branches shall occur at transfer switches where more than one transfer switch is required.

6.4.2.2.1.3

Each branch shall be arranged for connection, within time limits specified in this chapter, to an alternate source of power following a loss of the normal source.

6.4.2.2.1.4

The number of transfer switches to be used shall be based upon reliability, design, and load considerations.

(A)

Each branch of the essential electrical system shall have one or more transfer switches.

(B)

One transfer switch shall be permitted to serve one or more branches in a facility with a continuous load on the switch of 150 kVA (120 kW) or less.

6.4.2.2.2 Feeders From Alternate Source

6.4.2.2.2.1

A single feeder supplied by a local or remote alternate source shall be permitted to supply the essential electrical system to the point at which the life safety, critical, and equipment branches are separated.

6.4.2.2.2.2

Installation of the transfer equipment shall be permitted at other than the location of the alternate source.

6.4.2.2.3 Life Safety Branch

6.4.2.2.3.1

The life safety branch shall be limited to circuits essential to life safety.

6.4.2.2.3.2

The life safety branch shall supply power for lighting, receptacles, and equipment as follows:

Illumination of means of egress in accordance with NFPA 101, Life Safety Code

Exit signs and exit directional signs in accordance with NFPA 101, Life Safety Code

\*Hospital communications systems, where used for issuing instruction during emergency conditions

Generator set location as follows:

Task illumination

Battery charger for emergency battery-powered lighting unit(s)

Select receptacles at the generator set location and essential electrical system transfer switch locations

Elevator cab lighting, control, communications, and signal systems

Electrically powered doors used for building egress

Fire alarms and auxiliary functions of fire alarm combination systems complying with NFPA 72, National Fire Alarm and Signaling Code

6.4.2.2.3.3

Alarm and alerting systems (other than fire alarm systems) shall be connected to the life safety branch or critical branch.

6.4.2.2.3.4

Loads dedicated to a specific generator, including the fuel transfer pump(s), ventilation fans, electrically operated louvers, controls, cooling system, and other generator accessories essential for generator operation, shall be connected to the life safety branch or the output terminals of the generator with overcurrent protective devices.

6.4.2.2.3.5

No functions other than those in 6.4.2.2.3.2, 6.4.2.2.3.3, and 6.4.2.2.3.4 shall be connected to the life safety branch, except as specifically permitted in 6.4.2.2.3.

6.4.2.2.4\* Critical Branch

6.4.2.2.4.1

The critical branch shall be permitted to be subdivided into two or more branches.

6.4.2.2.4.2

The critical branch shall supply power for task illumination, fixed equipment, select receptacles, and select power circuits serving the following areas and functions related to patient care:

Critical care areas that utilize anesthetizing gases, task illumination, select receptacles, and fixed equipment

Isolated power systems in special environments

Task illumination and select receptacles in the following:

Patient care rooms, including infant nurseries, selected acute nursing areas, psychiatric bed areas (omit receptacles), and ward treatment rooms

Medication preparation areas

Pharmacy dispensing areas

Nurses' stations (unless adequately lighted by corridor luminaires)

Additional specialized patient care task illumination and receptacles, where needed

Nurse call systems

Blood, bone, and tissue banks

\*Telephone equipment rooms and closets

Task illumination, select receptacles, and select power circuits for the following areas:

General care beds with at least one duplex receptacle per patient bedroom, and task illumination as required by the governing body of the health care facility

Angiographic labs

Cardiac catheterization labs

Coronary care units

Hemodialysis rooms or areas

Emergency room treatment areas (select)

Human physiology labs

Intensive care units

Postoperative recovery rooms (select)

Additional task illumination, receptacles, and select power circuits needed for effective facility operation, including single-phase fractional horsepower motors, which are permitted to be connected to the critical branch

6.4.2.2.5 Equipment Branch

6.4.2.2.5.1 General

The equipment branch shall be connected to equipment described in 6.4.2.2.5.3 through 6.4.2.2.5.4.

6.4.2.2.5.2 Connection to Alternate Power Source

(A)

The equipment branch shall be installed and connected to the alternate power source, such that equipment described in 6.4.2.2.5.3 is automatically restored to operation at appropriate time-lag intervals following the energizing of the life safety and critical branches.

(B)

The arrangement of the connection to the alternate power source shall also provide for the subsequent connection of equipment described in 6.4.2.2.5.4.

6.4.2.2.5.3\* Equipment for Delayed-Automatic Connection

(A)

The following equipment shall be permitted to be arranged for delayed-automatic connection to the alternate power source:

Central suction systems serving medical and surgical functions, including controls, with such suction systems permitted to be placed on the critical branch

Sump pumps and other equipment required to operate for the safety of major apparatus, including associated control systems and alarms

Compressed air systems serving medical and surgical functions, including controls, with such air systems permitted to be placed on the critical branch

Smoke control and stair pressurization systems

Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood

Supply, return, and exhaust ventilating systems for the following:

Airborne infectious/isolation rooms

Protective environment rooms

Exhaust fans for laboratory fume hoods

Nuclear medicine areas where radioactive material is used

Ethylene oxide evacuation

Anesthetic evacuation

(B)

Where delayed-automatic connection is not appropriate, the ventilation systems specified in 6.4.2.2.5.3(A) (6) shall be permitted to be placed on the critical branch.

6.4.2.2.5.4\* Equipment for Delayed-Automatic or Manual Connection

The following equipment shall be permitted to be arranged for either delayed-automatic or manual connection to the alternate power source (also see A.6.4.2.2.5.3):

Heating equipment used to provide heating for operating, delivery, labor, recovery, intensive care, coronary care, nurseries, infection/isolation rooms, emergency treatment spaces, and general patient rooms; and pressure maintenance (jockey or make-up) pump(s) for water-based fire protection systems

\*Heating of general patient rooms during disruption of the normal source shall not be required under any of the following conditions:

Outside design temperature is higher than —6.7°C (+20°F)

Outside design temperature is lower than —6.7°C (+20°F), where a selected room(s) is provided for the needs of all confined patients [then only such room(s) need be heated].

Elevator(s) selected to provide service to patient, surgical, obstetrical, and ground floors during interruption of normal power

Supply, return, and exhaust ventilating systems for surgical and obstetrical delivery suites, intensive care, coronary care, nurseries, and emergency treatment spaces

Hyperbaric facilities

Hypobaric facilities

Autoclaving equipment, which is permitted to be arranged for either automatic or manual connection to the alternate source

Controls for equipment listed in 6.4.2.2.4

\*Other selected equipment

6.4.2.2.6 Wiring Requirements

6.4.2.2.6.1\* Separation From Other Circuits

The life safety branch and critical branch shall be kept independent of all other wiring and equipment.

6.4.2.2.6.2 Receptacles

The requirements for receptacles shall comply with 6.4.2.2.6.2(A), 6.4.2.2.6.2(B), and 6.4.2.2.6.2(C).

(A)

The number of receptacles on a single branch circuit for areas described in 6.4.2.2.3.3(8) shall be minimized to limit the effects of a branch-circuit outage.

(B)

Branch-circuit overcurrent devices shall be readily accessible to authorized personnel.

(C)\*

The electrical receptacles or the cover plates for the electrical receptacles supplied from the life safety and critical branches shall have a distinctive color or marking so as to be readily identifiable.

6.4.2.2.6.3 Switches

Switches of all types shall be permitted in the lighting circuits connected to the essential electrical system that do not serve as the illumination of egress as required by NFPA 101, Life Safety Code.

6.4.2.2.6.4 Mechanical Protection of the Life Safety and Critical Branches

The wiring of the life safety and critical branches shall be mechanically protected by raceways, as defined in NFPA 70, National Electrical Code.

6.4.2.2.6.5

Flexible power cords of appliances or other utilization equipment connected to the life safety and critical branches shall not be required to be enclosed in raceways.

6.4.2.2.6.6

Secondary circuits of transformer-powered communication or signaling systems shall not be required to be enclosed in raceways unless otherwise specified by Chapters 7 or 8 of NFPA 70, National Electrical Code.

6.4.3 Performance Criteria and Testing (Type 1 EES)

6.4.3.1 Source

The life safety and critical branches shall be installed and connected to the alternate power source specified in 6.4.1.1.4 and 6.4.1.1.5 so that all functions specified herein for the life safety and critical branches are automatically restored to operation within 10 seconds after interruption of the normal source.

6.4.3.2 Transfer Switches

6.4.3.2.1

All ac-powered support and accessory equipment necessary to the operation of the EPS shall be supplied from the load side of the automatic transfer switch(es), or the output terminals of the EPS, ahead of the main EPS overcurrent protection, as necessary, to ensure continuity of the EPSS operation and performance. [110:7.12.5]

6.4.3.2.2

The essential electrical system shall be served by the normal power source, except when the normal power source is interrupted or drops below a predetermined voltage level. Settings of the sensors shall be determined by careful study of the voltage requirements of the load.

6.4.3.2.3

Failure of the normal source shall automatically start the alternate source generator after a short delay, as described in 6.4.2.1.5.4. When the alternate power source has attained a voltage and frequency that satisfies minimum operating requirements of the essential electrical system, the load shall be connected automatically to the alternate power source.

6.4.3.2.4

Upon connection of the alternate power source, the loads comprising the life safety and critical branches shall be automatically re-energized. The load comprising the equipment system shall be connected either automatically after a time delay, as described in 6.4.2.1.5.6, or nonautomatically and in such a sequential manner as not to overload the generator.

6.4.3.2.5

When the normal power source is restored, and after a time delay, as described in 6.4.2.1.5.7, the automatic transfer switches shall disconnect the alternate source of power and connect the loads to the normal power source. The alternate power source generator set shall continue to run unloaded for a preset time delay, as described in 6.4.2.1.5.9.

6.4.3.2.6

If the emergency power source fails and the normal power source has been restored, retransfer to the normal source of power shall be immediate, bypassing the retransfer delay timer.

6.4.3.2.7

If the emergency power source fails during a test, provisions shall be made to immediately retransfer to the normal source.

6.4.3.2.8

Nonautomatic transfer switching devices shall be restored to the normal power source as soon as possible after the return of the normal source or at the discretion of the operator.

6.4.4 Administration (Type 1 EES)

6.4.4.1 Maintenance and Testing of Essential Electrical System

6.4.4.1.1 Maintenance and Testing of Alternate Power Source and Transfer Switches

6.4.4.1.1.1 Maintenance of Alternate Power Source

The generator set or other alternate power source and associated equipment, including all appurtenance parts, shall be so maintained as to be capable of supplying service within the shortest time practicable and within the 10-second interval specified in 6.4.1.1.10 and 6.4.3.1.

6.4.4.1.1.2

The 10-second criterion shall not apply during the monthly testing of an essential electrical system. If the 10-second criterion is not met during the monthly test, a process shall be provided to annually confirm the capability of the life safety and critical branches to comply with 6.4.3.1.

6.4.4.1.1.3

Maintenance shall be performed in accordance with NFPA 110, Standard for Emergency and Standby Power Systems, Chapter 8.

6.4.4.1.1.4 Inspection and Testing

Criteria, conditions, and personnel requirements shall be in accordance with 6.4.4.1.1.4(A) through 6.4.4.1.1.4(C).

(A)\* Test Criteria

Generator sets shall be tested 12 times a year, with testing intervals of not less than 20 days nor more than 40 days. Generator sets serving essential electrical systems shall be tested in accordance with NFPA 110, Standard for Emergency and Standby Power Systems, Chapter 8.

(B) Test Conditions

The scheduled test under load conditions shall include a complete simulated cold start and appropriate automatic and manual transfer of all essential electrical system loads.

(C) Test Personnel

The scheduled tests shall be conducted by competent personnel to keep the machines ready to function and, in addition, serve to detect causes of malfunction and to train personnel in operating procedures.

6.4.4.1.2 Maintenance and Testing of Circuitry

6.4.4.1.2.1\* Circuit Breakers

Main and feeder circuit breakers shall be inspected annually, and a program for periodically exercising the components shall be established according to manufacturer's recommendations.

6.4.4.1.2.2 Insulation Resistance

The resistance readings of main feeder insulation shall be taken prior to acceptance and whenever damage is suspected.

6.4.4.1.3 Maintenance of Batteries

Batteries for on-site generators shall be maintained in accordance with NFPA 110, Standard for Emergency and Standby Power Systems.

6.4.4.2 Record Keeping

A written record of inspection, performance, exercising period, and repairs shall be regularly maintained and available for inspection by the authority having jurisdiction.

6.5 Essential Electrical System Requirements — Type 2

6.5.1 Sources (Type 2 EES)

The requirements for sources for Type 2 essential electrical systems shall conform to those listed in 6.4.1.

6.5.2 Distribution (Type 2 EES)

6.5.2.1 General

The distribution requirements for Type 2 essential electrical systems shall conform to those listed in 6.4.2.1.

6.5.2.1.1\* Selective Coordination

6.5.2.1.1.1

Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.1 second.

6.5.2.1.1.2

Selective coordination shall not be required as follows:

Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary. [70:700.27]

Between overcurrent protective devices of the same size (ampere rating) in series. [70:700.27]

6.5.2.2 Specific Requirements

6.5.2.2.1\* General

6.5.2.2.1.1

The number of transfer switches to be used shall be based upon reliability, design, and load considerations.

6.5.2.2.1.2

Each branch of the essential electrical system shall have one or more transfer switches.

6.5.2.2.1.3

One transfer switch shall be permitted to serve one or more branches in a facility with a continuous load on the switch of 150 kVA (120 kW) or less.

6.5.2.2.2 Life Safety Branch

6.5.2.2.2.1

The life safety and critical branches shall supply power for lighting, receptacles, and equipment as follows:

Illumination of means of egress in accordance with NFPA 101, Life Safety Code

Exit signs and exit directional signs in accordance with NFPA 101, Life Safety Code

Alarm and alerting systems, including the following:

Fire alarms

Alarms required for systems used for the piping of nonflammable medical gases as specified in Chapter 5

\*Communications systems, where used for issuing instructions during emergency conditions

Sufficient lighting in dining and recreation areas to provide illumination to exit ways of a minimum of 5 ft-candles

Task illumination and select receptacles at the generator set location

Elevator cab lighting, control, communications, and signal systems

6.5.2.2.2.2

No functions, other than those listed in 6.5.2.2.2.1(1) through (7), shall be connected to the life safety.

6.5.2.2.3 Equipment Branch

6.5.2.2.3.1 General

(A)

The equipment branch shall be installed and connected to the alternate power source such that equipment listed in 6.5.2.2.3.2 is automatically restored to operation at appropriate time-lag intervals following the restoration of the life safety and equipment branches to operation.

(B)

The equipment branch arrangement shall also provide for the additional connection of equipment listed in 6.5.2.2.3.3.

6.5.2.2.3.2 AC Equipment for Nondelayed-Automatic Connection

Generator accessories including, but not limited to, the transfer fuel pump, electrically operated louvers, and other generator accessories essential for generator operation shall be arranged for automatic connection to the alternate power source.

6.5.2.2.3.3 Delayed-Automatic Connections to Equipment Branch

The following equipment shall be permitted to be connected to the equipment branch and shall be arranged for delayed-automatic connection to the alternate power source:

Task illumination and select receptacles in the following:

Patient care rooms

Medication preparation areas

Pharmacy dispensing areas

Nurses' stations (unless adequately lighted by corridor luminaires)

Supply, return, and exhaust ventilating systems for airborne infectious isolation rooms

Sump pumps and other equipment required to operate for the safety of major apparatus and associated control systems and alarms

Smoke control and stair pressurization systems

Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood

6.5.2.2.3.4\* Delayed-Automatic or Manual Connections to Equipment Branch

The equipment in 6.5.2.2.3.4(A) and 6.5.2.2.3.4(B) shall be permitted to be connected to the equipment branch and shall be arranged for either delayed-automatic or manual connection to the alternate power source.

(A) Heating Equipment to Provide Heating for General Patient Rooms

Heating of general patient rooms during disruption of the normal source shall not be required under any of the following conditions:

\*The outside design temperature is higher than —6.7°C (+20°F).

The outside design temperature is lower than —6.7°C (+20°F) and, where a selected room (s) is provided for the needs of all confined patients, then only such room(s) need be heated.

The facility is served by a dual source of normal power. See A.6.4.1.1.1 for more information.

(B) \* Elevator Service

In instances where interruptions of power would result in elevators stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of passengers.

(C) Optional Connections to the Equipment Branch

Additional illumination, receptacles, and equipment shall be permitted to be connected only to the equipment branch.

(D) Multiple Systems

Where one switch serves multiple systems as permitted in 6.5.2.2, transfer for all loads shall be non-delayed automatic.

6.5.2.2.4 Wiring Requirements

6.5.2.2.4.1\* Separation From Other Circuits

The life safety and equipment branches shall be kept entirely independent of all other wiring and equipment.

6.5.2.2.4.2\* Receptacles

The electrical receptacles or the cover plates for the electrical receptacles supplied from the life safety and equipment branches shall have a distinctive color or marking so as to be readily identifiable.

6.5.3 Performance Criteria and Testing (Type 2 EES)

6.5.3.1 Source

The life safety and equipment branches shall be installed and connected to the alternate source of power specified in 6.4.1.1.4 and 6.4.1.1.5 so that all functions specified herein for the life safety and equipment branches are automatically restored to operation within 10 seconds after interruption of the normal source.

6.5.3.2 Transfer Switches

The essential electrical system shall be served by the normal power source until the normal power source is interrupted or drops below a predetermined voltage level. Settings of the sensors shall be determined by careful study of the voltage requirements of the load.

6.5.3.2.1

Failure of the normal source shall automatically start the alternate source generator after a short delay, as described in 6.4.2.1.5.4. When the alternate power source has attained a voltage and frequency that satisfies minimum operating requirements of the essential electrical system, the load shall be connected automatically to the alternate power source.

6.5.3.2.2

All ac-powered support and accessory equipment necessary to the operation of the EPS shall be supplied from the load side of the automatic transfer switch(es), or the output terminals of the EPS, ahead of the main EPS overcurrent protection to ensure continuity of the EPSS operation and performance. [110:7.1.12.5]

6.5.3.2.3

Upon connection of the alternate power source, the loads comprising the life safety and equipment branches shall be automatically re-energized. The loads comprising the equipment branch shall be connected either automatically after a time delay, as described in 6.4.2.1.5.6, or nonautomatically and in such a sequential manner as not to overload the generator.

6.5.3.2.4

When the normal power source is restored, and after a time delay as described in 6.4.2.1.5.7, the automatic transfer switches shall disconnect the alternate source of power and connect the loads to the normal power source. The alternate power source generator set shall continue to run unloaded for a preset time delay as described in 6.4.2.1.5.9.

6.5.3.2.5

If the emergency power source fails and the normal power source has been restored, retransfer to the normal source of power shall be immediate, bypassing the retransfer delay timer.

6.5.3.2.6

If the emergency power source fails during a test, provisions shall be made to immediately retransfer to the normal source.

6.5.3.2.7

Nonautomatic transfer switching devices shall be restored to the normal power source as soon as possible after the return of the normal source or at the discretion of the operator.

6.5.4 Administration (Type 2 EES)

6.5.4.1 Maintenance and Testing of Essential Electrical System

6.5.4.1.1 Maintenance and Testing of Alternate Power Source and Transfer Switches

6.5.4.1.1.1 Maintenance of Alternate Power Source

The generator set or other alternate power source and associated equipment, including all appurtenance parts, shall be so maintained as to be capable of supplying service within the shortest time practicable and within the 10-second interval specified in 6.4.1.1.7 and 6.4.3.1.

6.5.4.1.1.2 Inspection and Testing

Generator sets shall be inspected and tested in accordance with 6.4.4.1.1.3.

6.5.4.1.2 Maintenance and Testing of Circuitry

Circuitry shall be maintained and tested in accordance with 6.4.4.1.2.

6.5.4.1.3 Maintenance of Batteries

Batteries shall be maintained in accordance with 6.4.4.1.3.

6.5.4.2 Record Keeping

A written record of inspection, performance, exercising period, and repairs shall be regularly maintained and available for inspection by the authority having jurisdiction.

6.6 Essential Electrical System Requirements — Type 3

6.6.1 Sources (Type 3 EES)

The alternate source of power for the system shall be specifically designed for this purpose and shall be either a generator, battery system, or self-contained battery integral with the equipment.

6.6.1.1

Generators shall conform to 6.4.1.1 and 6.4.1.1.6.2.

6.6.1.2

Battery systems shall conform to 6.4.1.2.

6.6.2 Distribution (Type 3 EES)

6.6.2.1 General

The distribution requirements for Type 3 essential electrical systems shall conform to those listed in 6.4.2.1.

6.6.2.1.1\* Selective Coordination

6.6.2.1.1.1

Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.1 second.

6.6.2.1.1.2

Selective coordination shall not be required as follows:

Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary. [70:700.27]

Between overcurrent protective devices of the same size (ampere rating) in series. [70:700.27]

6.6.2.2 Specific Requirements

6.6.2.2.1\* General

6.6.2.2.2 Connection to the Essential Electrical System

The system shall supply power for task illumination that is related to the safety of life and that is necessary for the safe cessation of procedures in progress.

6.6.2.2.3 Wiring Requirements

6.6.2.2.3.1 General

The design, arrangement, and installation of the system shall be in accordance with NFPA 70, National Electrical Code.

6.6.2.2.3.2\* Receptacles

The cover plates for the electrical receptacles or the electrical receptacles themselves supplied from the life safety and critical branches shall have a distinctive color or marking so as to be readily identifiable.

6.6.3 Performance Criteria and Testing (Type 3 EES)

6.6.3.1 Source

6.6.3.1.1

The life safety branch shall have an alternate source of power separate and independent from the normal source that will be effective for a minimum of 1 1/2 hours after loss of the normal source.

6.6.3.1.2

The life safety branch shall be so arranged that, in the event of failure of the normal power source, the alternate source of power shall be automatically connected to the load within 10 seconds

6.6.3.2 Transfer Switches With Engine Generator Sets

6.6.3.2.1

The operation of the equipment shall be arranged such that the load will be served by the normal source until the normal source is interrupted or when the voltage drops below the setting of the voltage-sensing device.

6.6.3.2.2

The settings of the voltage-sensing relays shall be determined by careful study of the voltage requirements of the load.

6.6.3.2.3

When the normal source is restored, and after a time delay as described in 6.4.2.1.5.7, the automatic transfer switch shall disconnect the alternate source of power and connect the loads to the normal power source.

6.6.3.2.4

If the alternate power source fails and the normal power source has been restored, retransfer to the normal source of power shall be immediate.

6.6.3.3 Transfer Switches With Battery System

6.6.3.3.1

Failure of the normal source shall automatically transfer the load to the battery system.

6.6.3.3.2

Retransfer to the normal source shall be automatic upon restoration of the normal source.

6.6.4 Administration (Type 3 EES)

6.6.4.1 Maintenance and Testing

6.6.4.1.1 Maintenance and Testing of Alternate Power Source and Transfer Switches

6.6.4.1.1.1 Maintenance of Alternate Power Source

The generator set or other alternate power source and associated equipment, including all appurtenance parts, shall be so maintained as to be capable of supplying service within the shortest time practicable and within the 10-second interval specified in 6.4.1.1.10 and 6.6.3.1.2.

6.6.4.1.1.2 Inspection and Testing

Generator sets shall be inspected and tested in accordance with 6.4.4.1.1.3.

6.6.4.1.1.3 Stored Energy Power Source

Maintenance and testing of stored energy power supply systems shall be in accordance with NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems, Section 6.1 through 6.4.5.

6.6.4.1.2 Maintenance and Testing Circuitry

Circuitry shall be maintained and tested in accordance with 6.4.4.1.2.

Batteries shall be maintained in accordance with 6.4.4.1.3.

6.6.4.2 Record Keeping

A written record of inspection, performance, exercising period, and repairs shall be regularly maintained and available for inspection by the authority having jurisdiction.